EFFECT OF NUCLEATION METHODS ON CHARACTERISTICS OF LOW-TEMPERATURE DEPOSITED ULTRANANOCRYSTALLINE DIAMOND

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Abstract

Ultra-nano-crystalline diamond (UNCD) thin films possess very fine grains and very smooth surface. These films are very promising for the applications in a device requiring smooth surface, such as surface acoustic wave (SAW) devices. UNCD films can be grown using CH_4/Ar plasma at relatively lower substrate temperature, which renders the formation of UNCD on a glass substrate possible and increases tremendously the potential for device applications. However, in order to deposit the diamond films at low substrate temperature, creation of nucleation sites is necessary. In this study, various kinds of nucleation methods were used for enhancing the formation of ultra-nano-crystalline diamond (UNCD) films. The surface morphologies and other properties of these UNCD films were observed to correlate intimately with nucleation methods.

UNCD films were grown in a 2.45 GHz microwave plasma enhanced chemical vapor deposition (MPECVD) system on mirror polished Si (100) substrates. The substrate assembly was immersed in 1200 W CH_4/Ar plasma with 1 % CH_4, 99 % gas mixture at total pressure of 150 Torr. The substrates were pretreated either by (1) scratching with submicron (0.1 μm) or nano-sized (~ 3 nm) diamond powders; (2) ultrasonically polished with submicron (0.1 μm) or nano-sized diamond (~3 nm) powders; (3) spin coating slurry containing nano-sized diamond powder as seeds; or (4) by bias enhanced nucleation (BEN) method. The results showed that the growth rate and surface morphologies of UNCD films are significantly affected by nucleation methods, although all the UNCD films showed similar grain size and Raman spectra.

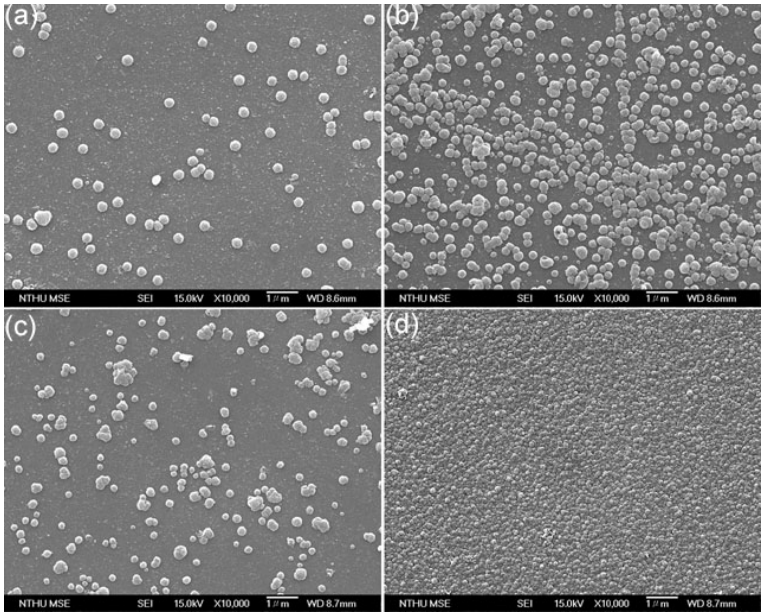

Figure* 1.** ***SEM surface morphology of UNCD grown under 400^{o}C, 3 hr on different nucleation substrate a) scratched by0.1 mm diamond powder; b) scratched by nano-sized powder; c) ultrasonic by nano-sized powder; d) bias enhanced nucleation substrate .

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